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AN ACCEPTANCE TEST OF A HAMILTON-HOLZWARTH TURBO-GENERATOR AT BELOIT, WISCONSIN

AN ACCEPTANCE TEST OF A HAMILTON-HOLZWARTH TURBO-GENERATOR AT BELOIT WISCONSIN

A Thesis Submitted by

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TABLE OF CONTENTS

AN ACCEPTANCE TEST OF A HAMILTON-HOLZWARTH TURBO-GENERATOR AT BELOIT WISCONSIN.

INTRODUCTION.

Although the steam turbine is a comparatively new form of prime mover, it is rapidly coming into use in the smaller power plants as well as in the larger ones.

The new plant of the Beloit Water, Gas and Electric Company, at Beloit Wisconsin is a good example of a small plant using this type of power generator. The plant is situated about half a mile north of the business section of the city, on the east bank of the Rock River. The new building is north of the old plant and it is designed so that it can easily be expanded into a larger plant if necessary. The apparatur is all new and up to date, and the arrangement, with one or two exceptions, is all that could be desired.

OBJECT OF TEST.

The object of the test upon which this thesis is based, was primarily to find the steam consumption of the turbine in pounds per kilowatt per hour. It was also desired to make a complete plant test, but this was found impracticable on account of existing conditions. Therefore, only the turbine was tested.

The test consisted of six runs: on March eighteenth nineteen hundred and eight, a no-load run of two hours was made; on March twentieth, a quarter-load run of two hours, a half-load run of three hours, and a three-quarter-load run of two hours were made; a full load run of seven and one-half hours was made on April ninth; and a two hour over-load run was made on April tenth.

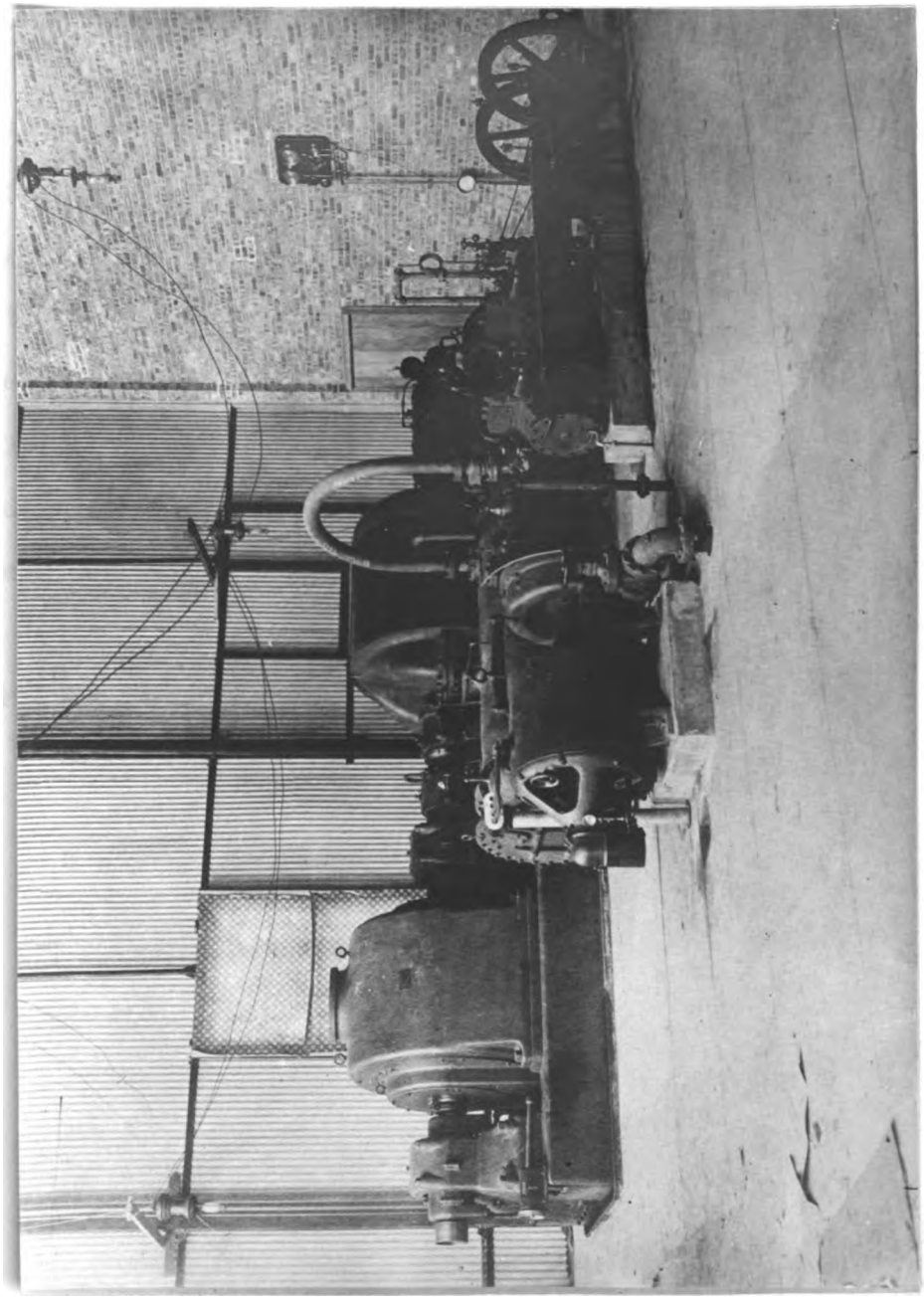
DESCRIPTION OF THE PLANT.

The equipment consists of a Hamilton-Holzwarth Steam Turbine direct connected to a Crocker-Wheeler Alternator, all located on the same base. The turbine is a seven hundred and fifty brake horse-power, impulse turbine, built to run condensing at a speed of eighteen hundred revolutions per minute. Its special features will later be described in detail.

The generator is a three phase, five hundred kilowatt machine, with a voltage of twenty-three hundred, delivering one hundred and twenty-five amperes per phase and having a frequency of sixty at eighteen hundred revolutions per minute.

The steam furnished to the turbine is generated by a battery of two Babcock and Wilcox water tube boilers each of three hundred and fifty horse power capacity. Each boiler is fourteen feet wide by twelve feet high, contains one hundred sixty-eight four inch tubes eighteen feet long, and two forty-inch drums one-half inch thick, twenty-three feet, three and fife eights inches long, built of ope hearth steel and capable of carrying a pressure of two hundred pounds per square inch.

The auxiliaries consist of an Allberger surface condenser, and Allberger tandem horizontal dry vacuum pump 6 x 14 x 14 x 10, two Fairbanks-Morse feed water pumps, two centrifugal pumps driven by induction motors- the larger one



Turbine and Auxiliaries.

pumping the circulating water, and the smaller, the water, from the condenser and the hot well -, a Cochrane feed water heater and purifier, an oiling system, consisting of a Phoenix pump, filter and cooler, a steam separator, and other auxiliaries necessary in a plant of this kind.

The exciting current for the generator is furnished by a twnety-five kilowatt Curtis Turbo-generator.

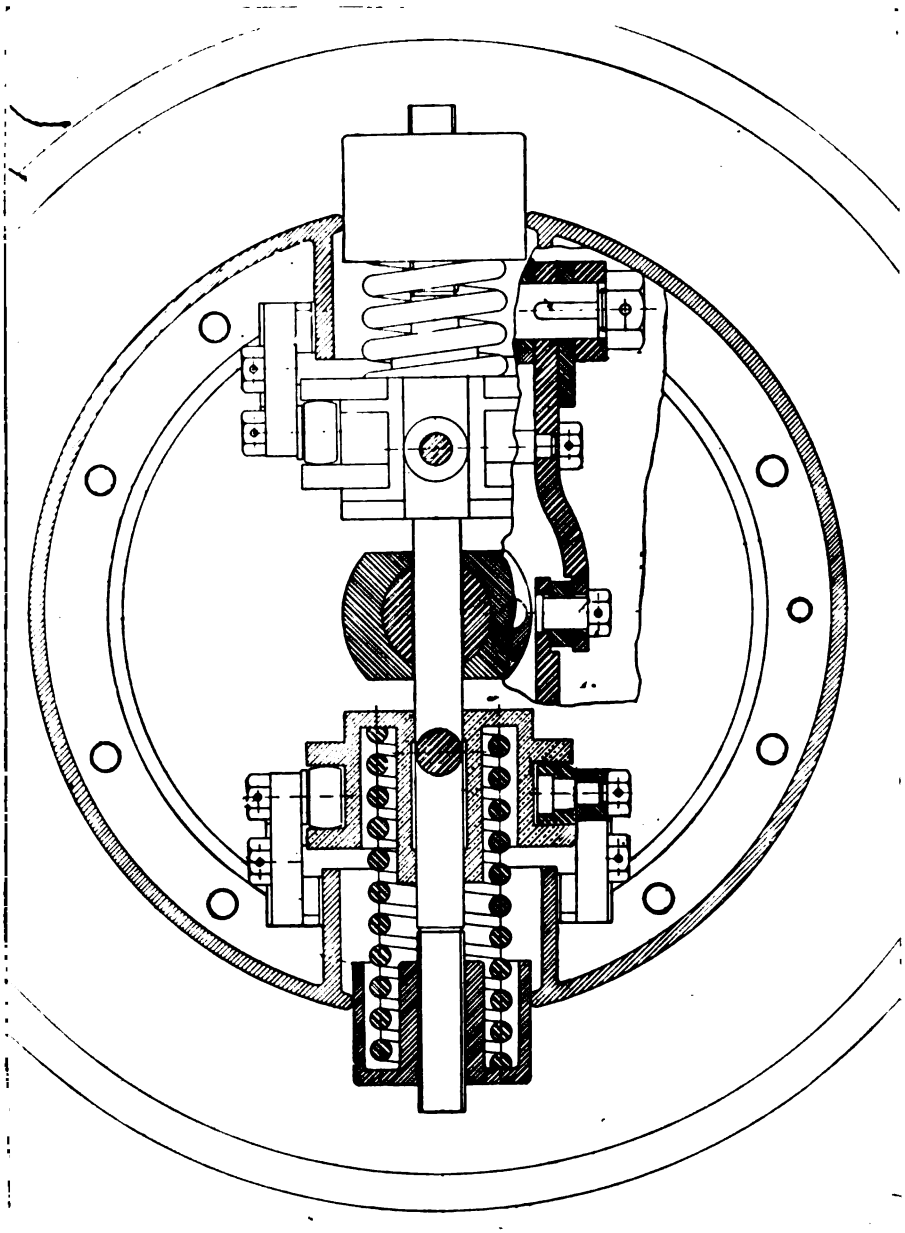
The switchboard is of the direct control type, having the main switches and circuit breakers at the board, ammeters and wattmeters for each phase, one voltmeter for each machine, which can be plugged in on any phase, synchronizer, Tyrell regulator, etc. A separate panel is provided for the exciter, which has an ammeter, voltmeter and wattmeter together with rheostat and switches.

DESCRIPTION OF TURBINE.

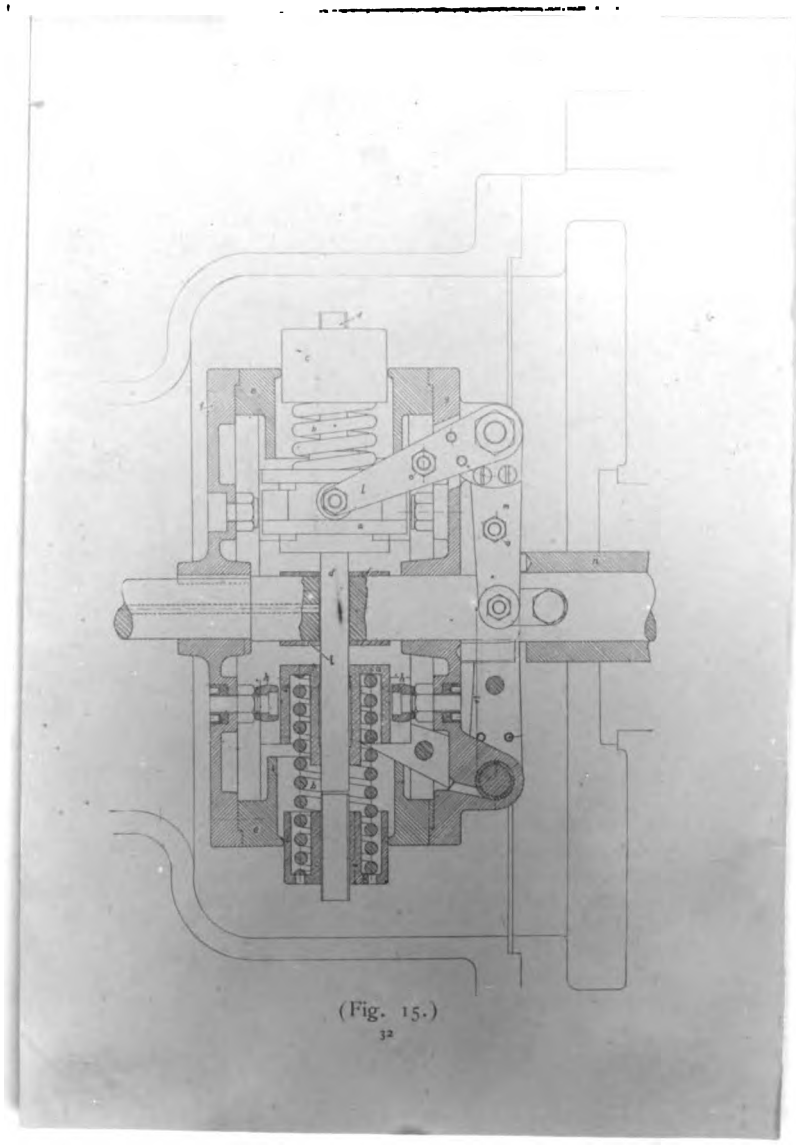
The Hamilton-Holzwarth turbine resembles the Parsons in that steam flows through the turbine in a continuous belt. But, whereas in the Parsons type, the steam expands both in the guide vanes and in the wheel buckets, in the Hamilton-Holzwarth type, the expansion is confined to the guide vanes, thus resembling the Rateau turbine. It also differs from the Parsons and resembles the Rateau in having distinct wheels for each set of blades.

The theory and design of this type of turbine depends upon the fact that the steam pressure decreases in each set of guide vanes, but remains constant during the passage from one side to the other of each set of wheel blades.

The turbine wheel in itself shows a practical design. It consists of a steel hub having a bore which fits the shaft closely. On both sides of the hub are riveted steel disks. A groove is turned on the outer circumference of the disk, forming a recepticle for the running buckets. The buckets are made of a good quality of steel and are shaped in such a manner as will give the best efficiency for the speed and number of stages to be used. A great deal of care is taken in the balancing and fastening of this wheel. The wheel is balanced for static balance and then for running balance. The wheels are all so tested out at a considerably higher speed than their normal running speed before leaving



Governor, End View.



(Fig. 15.)

32

Governor, Side View.

the shop. They are secured to the turbine shaft by means of a feather key running through the wheel and also by means of a nut screwed on the shaft and pressing the wheels firmly against a shoulder forged on the shaft.

The stationary disks are constructed of cast iron and have a bore slightly larger than the shaft, allowing for the clearance which is made as small as possible in order to reduce the leakage losses to a minimum. The vanes are made of drop forged steel and are milled to get accurate spacing and entrance angles; they are located in a groove in the edge of the disk and are secured by a tough steel ring . After the vanes are riveted to the disks the whole is accurately milled. The stationary disks are held in grooves in the turbine casing, which is split horizontally.

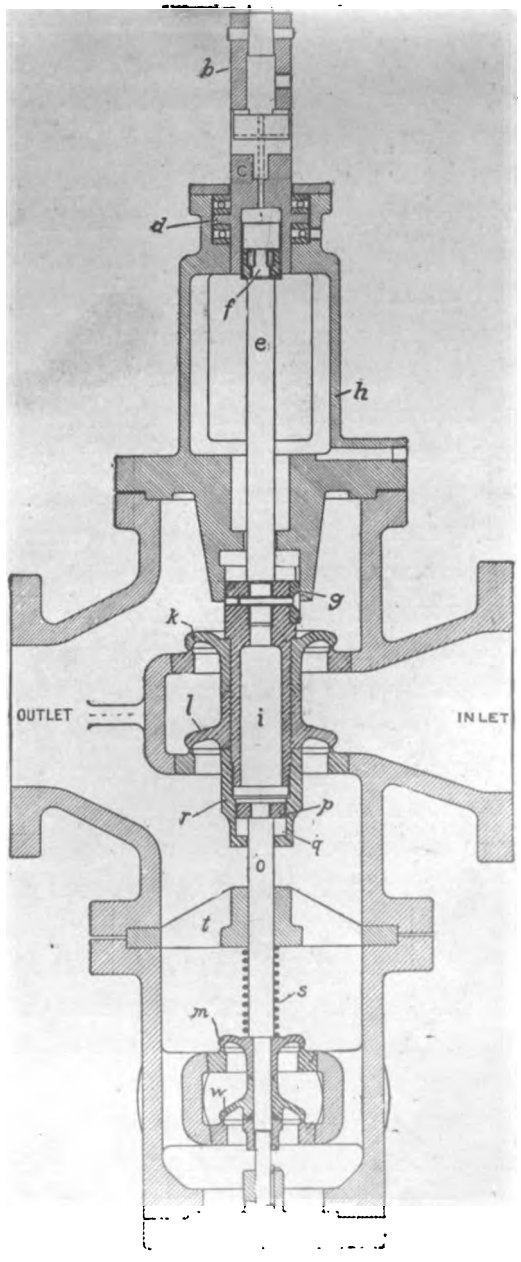
The governor used is of the spring and weight type, especially designed for high speeds. It is on a shaft directly connected to the turbine shaft, and thus revolves with the same angular velocity. Two disks key-seated to the shaft, drive, by means of rollers, two weights sliding across a cross bar, placed at right angles through the shaft, and compressing two springs against two nuts on the same cross-bar. Every movement of the weights caused by increasing or decreasing the speed of the turbine shaft, is transmitted by means of levers to a sleeve which actuates the regulating mechanism. These levers are designed in such a manner that

they balance themselves so that no back ;pressure due to centrifugal forces is exerted upon the weights.

In order to decrease the friction within the governor and the regulating mechanism, thrust ball bearings and roller bearings are used. To avoid the friction due to the shifting of the governor sleeve along the key which transmits the turning moment of the shaft, the shaft is coupled to the sleeve by means of a special coupling.

The governor does not actuate the main regulating valve directly; for if such an arrangement existed, it would throw a resistance upon the governor, which resistance varies with the load, and therefore tends to prevent the positive action of the governor.

The stem of the regulating valve is driven by means of bevel gears on a shaft, upon which is also found a friction wheel which the governor can slide across the face of a friction disk, by means of a bell crank and lever. The continually revolving friction disk is keyed to a solid shaft which is driven by a coupling from a hollow shaft, which in its turn is driven by means of a worm gear on the turbine shaft. The solid shaft with the continuously revolving friction disk, can be shifted slightly by the governor sleeve so that the two friction disks come into contact when the sleeve moves, that is when the speed changes. Should this change be relatively great, the sleeve will draw the period-



Regulating Valve.

ically revolving disk away from the center of the continously revolving disk, and this will instantly drive the stem of the regulating valve, thereby regulating the flow of steam. Should the speed fall below a certain percentage of the normal speed, the driving friction disk is drawn back by the governor, the regulating valve remains open and the whole regulating mechanism rests or stops, although the shaft is still in operation. When the speed of the turbine reaches a point two and one-half per cent. above the normal, the governor shuts down the whole turbine, as it would also do should any accident or breakdown occur.

The regulating valve is in its principle, a balanced poppet valve. It regulates the steam flow to the turbine, according to the load the turbine has to carry, by throttling the steam.

The mechanical features of this valve are shown in Figure 1. The stem A is set in motion indirectly by the governor as soon as the speed of the turbine changes. The stem A drives, by means of a coupling B a bushing C, This bushing is held in place by means of a flange D resting against two thrust bearings on each side. The bushing D is tapped and lifts the stem by turning the screw F into its tap. The stem E cannot turn because it runs with a feather key G in a keyway of a cap H. The stem E is screwed into the bushing E, and over this bushing fits the valve halves K and L. The valve is split for the purpose of

balancing. The steam valve is provided with a by-pass situated below the regulating valve.

The bearings are lubricated by means of a small oil pump located in the basement. By means of this pump an oil pressure is maintained in all of the bearings at all times. The oil, after passing through the bearings, flows back through a strainer and a cooler to the oil tank.

Since the more important details of this type of turbine have been discussed,it might be well to take up its operation.

The steam passes through the steam separator which is placed in the basement, and then comes to the main inlet valve which is controlled by a hand wheel located above the turbine room floor at the high pressure end of the turbine. The steam next passes through the regulating valve and then through a curved pipe to the high pressure end of the turbine. After passing the ring channel in the turbine head, the steam comes to the first set of stationary buckets, which are rigidly connected to the head. From here it flows in a continuous cylindrical belt through the successive stages, until it reaches the condenser.

An arrangement is provided so that in case of over loads, high pressure steam may also pass directly to the low pressure side. This by-pass arrangement is controlled by the governor.

METHOD OF MAKING TEST.

The energy generated was dissipated by means of a rheostat in the Rock River. The amount of the load was regulated by the depth that the plates of the rheostat were immersed in the river. The output was measured at the switchboard, where readings were taken of watts output, currents in each phase, and voltage. Readings were also taken of field current and voltage, but the power supplied to the generator field was not taken into account in computing the output. This power was obtained from the old plant, as the turbo-exciter was very uneconomical in its steam consumption. The quality of the steam was found at the separator, just ahead of the regulating valve, by means of a throttling calorimeter. Calorimeter readings were taken every thirty minutes except in the full load and no load runs when they were taken every twenty and fifteen minutes respectively. The pressures on each side of the regulating valve were taken, and the quality computed at the low pressure side, the radiation loss at the valve being taken at zero.

The amount of condensed steam leaving the condenser was measured by means of a water meter, which meter was checked by means of a weighing tank. Readings of the meter were taken at regular intervals, and the time of reading

noted. The difference in the readings was reduced to cubic feet per hour and these were changed to pounds per hour. These values were checked by allowing the water to flow into the weighing tank for a certain length of time, and reducing this amount to pounds per hour. This check was made every ten or fifteen minutes. In this way a fairly accurate check was kept on the meter. The meter was found to be correct to with one and one-half per cent. the water measured by this meter consisted of the condensed steam, the gland water for the hot well pump, and, except at full load, and over load, of the turbine sealing water. During the full load and over load runs, the low pressure turbine gland was sealed with steam. In order to obtain the true amount of steam used in the turbine, the gland water was subtracted from the total. The gland water was measured by means of small meters. These meters were later calibrated in the same manner as the large one, except that the calibration was not made during the runs. The temperature of the condensed steam was taken at the large meter.

The readings of barometer pressure, the vacuum at the turbine, for full load and over load, the vacuum at the condenser, the turbine speed, the temperatures of cooling water entering and leaving the condenser, boiler pressure, room temperature, and temperature of the air in the generator

were taken every ten minutes. On the full load and the over load runs, the vacuum temperature at the vacuum pump was noted. Indicator cards from each cylinder of the vacuum pump were taken together with the speed of the pump.

As all the electrical instruments were new and had been calibrated at the factory, they were considered as sufficiently accurate and were not again calibrated.

All the pressure gauges were calibrated before the test, and, as they had been set five pounds low for the first four tests, the readings were corrected in the data. They were again calibrated and adjusted before the full-load and over-load runs.

SUMMARY OF AVERAGE RESULTS.

No Load

Average Current (3phases) , Amperes,	———
" Voltage , Volts,	2300
" Kilowatts (Output of generator) K.W.,	41.85
" Speed R. P. M.	1725.
" Vacuum at Turbine , Inches Mercury	27.77
Exciter Current, amperes	22.19
" Pressure , Volts	71.00
Temp. of Circulating Water in, Deg F.	40.71
" " " " out, Deg.F.	44.30
" " Air to Generator in ,Deg F.	60.61
" " " from " out, Deg. F.	91.07
" Rise in Generator , Deg. F.	30.46
Average Bar. Pressure, Inches Mercury	28.94
" Boiler Pressure, Lbs. per sq. inch	152
" Pressure before reg. valve " "	76.9
" " after " " " "	00.0
" Quality before reg. valve, %	98.42
" " after " "	41° Superheat

Gland Water , Cu. Ft. per Hr. (105.18%)	41.47
" " , " " " " Corrected	39.45
Sealing Water " " " " (104%)	34.2
" " " " " " Corrected	32.9
Condensed Steam,(gross),Cu.Ft./Hr. (101.5),	132.
" " " " " " ,Corrected,	130.
" " Less Gland and Sealing Water, $\frac{\text{CuFt}}{\text{Hr}}$	57.65
" " Temperature, Deg. F.	77.4
" " , Pounds per hour (62.25)	3588
Steam Consumption, Lbs. Dry Steam per K.W. per Hr.	85.7

SUMMARY OF AVERAGE RESULTS.

1/4 Load.

Length of Run, hours		2
Current First Phase	Amps.	31.5
Current Second Phase	"	31.66
Current Third Phase	"	29.57
Pressure	Volts	2300.0
Power delivered at Switchboard	K.W.	119.33
Speed of Turbine	R.P.M.	1745.
Exciter Current	Amps.	22.0
Exciter Pressure	Volts	69.42
Temperature of Air into Generator	Deg.F.	54.92
Temperature of Air from Generator	"	85.33
Temperature Rise in Generator	"	30.41
Vacuum at Turbine	Inches Hg.	28.55
Barometer Pressure	" "	29.51
Boiler Pressure	Lbs./sq.in.	164.7
Pressure before Regulating Valve	" "	106.8
Pressure after " "	" "	25.25
Quality before " "	% Dryness	98.25
Quality after " "		16° Superheat

SUMMARY OF AVERAGE RESULTS.

(1/4 Load Continued)

Gland Water	Cu.Ft./Hr.	46.42
Gland Water Corrected	" "	44.15
Sealing Water	" " "	47.60
Sealing Water Corrected	" "	45.71
Condensed Steam (Gross)	" "	180.80
" " Corrected (Gross)	" "	178.00
" " Less gland and Sealing Water	" "	88.14
" " Temperature	Deg.F.	70.3
" "	Lbs.per Hr.	5491.
Steam Consumption, Dry Steam	Lbs./K.W./Hr.	46.01

SUMMARY OF AVERAGE RESULTS.

(1/2 Load)

Length of run	Hours	3
Current first Phase	Amps.	70.94
Current Second Phase	"	65.58
Current Third Phase	"	68.10
Pressure Volts	Volts	2300.
Power Delivered at Switchboard	K.W.	261.7
Speed of Turbine	R.P.M.	1742.
Exciter Current	Amps.	23.
Exciter Pressure	Volts	76.24
Temp. of Air into Generator	Deg. F.	58.47
Temp. of Air from Generator	"	96.26
Temp. Rise in "	"	37.79
Vacuum at Turbine	Ins. of Hg.	27.74
Barometer Pressure	" "	29.49
Boiler Pressure Gauge	Lbs./SqIn.	159.55
Pressure Before Reg. Valve "	" "	104.2
Pressure After " " "	" "	52.89
Quality before " "	Percent.	96.62
Quality after " "	"	98.20

SUMMARY OF AVERAGE RESULTS.

(1/2 Load)

Length of run	Hours	3
Current First Phase	Amps.	70.94
Current Second Phase	"	65.58
Current Third Phase	"	68.10
Pressure Volts	Volts	2300.
Power Delivered at Switchboard	K.W.	261.7
Speed of Turbine	R.P.M.	1742.
Exciter Current	Amps.	23.
Exciter Pressure	Volts	76.24
Temp. of Air into Generator	Deg. F.	58.47
Temp. of Air from Generator	"	96.26
Temp. Rise in "	"	37.79
Vacuum at Turbine	Ins. of Hg.	27.74
Barometer Pressure	" "	29.49
Boiler Pressure Gauge	Lbs./SqIn.	159.55
Pressure Before Reg. Valve "	" "	104.2
Pressure After " " "	" "	52.89
Quality before " "	Percent.	96.62
Quality after " "	"	98.20

SUMMARY OF AVERAGE RESULTS .

(1/2 Load Continued)

Gland Water		CU.Ft./Hr.	46.31
" "	Corrected	"	44.10
Sealing Water		"	51.70
" "		"	49.75
Condensed Steam	(Gross	"	253.13
" "	"	"	249.4
" "	Less Gland & Sealing Water	"	155.55
" "	Temperature Deg. F.	"	71.6
" "		Lbs./Hr.	96.9
Steam Consumption		Lbs./K.W./Hr.	37.03
" "	Lbs.Dry Steam/K.W./Hr.		36.3

SUMMARY OF AVERAGE RESULTS.

(3/4 Load)

Length of run	Hours	3.
Current 1st Phase	Amps.	90.80
Current 2nd Phase	"	93.85
Currend 3rd Phase	"	87.90
Pressure	Volts	2300.
Power Delivered at Switchboard	K.W.	358.1
Speed of Turbine	R.P.M.	1741.
Exciter Current	Amps.	24.00
Exciter Pressure	Volts	80.1
Temp. Of Air into Generator	Deg. F	62.58
Temp. of Air from "	"	101.79
Temperature Rise in "	"	39.21
Vacuum at Turbine	Ins. of Hg.	27.28
Barometer Pressure	" "	29.39
Boiler Pressure	#/Sq.In.	168.85
Pressure before Reg. Valve	"	102.84
Pressure after " "	"	69.05
Quality before " "	%	95.21
Quality after " "	%	96.5

SUMMARY OF AVERAGE RESULTS .

(3/4 Load Continued)

Gland Water	Cu.Ft./Hr.	46.39
" " Corrected	" "	44.15
Sealing Water	" "	49.11
" " "	" "	47.20
Condensed Steam (Gross)	" "	290.48
" " Corrected (Gross)	" "	286.00
" " Less Gland & Sealing Water	"	194.65
" " Temperature	Deg. F.	80.40
" "	Lbs./hr.	12009.
Steam Consumption	Lbs./K.W./Hr.	33.84
" " Lbs.Dry Steam/K.W./Hr.		32.65

SUMMARY OF AVERAGE RESULTS.

(Full Load)

Length of Run	Hours	7-1/2
Current, 1st Phase	Amps.	128.7
" 2nd "	"	124.1
" 3rd "	"	127.1
Pressure	Volts	2300.
Power delivered at Switchboard	K.W.	507.
Speed of Turbine	R.P.M.	1662
Exciter Current	Amps	25.41
" Pressure	Volts	87.2
Temp.of Air into Generator	Deg.F.	86.6
" " " from "	"	114.5
" Rise in "	"	45.9
Vacuum at Turbine	In.Hg.	26.44
Barometer Pressure	" "	29.31
Boiler Pressure	#/ Sq.In.	163.8
Pressure before Reg.Valve,Gauge	" "	159.
" after " " "	" "	104.2
Quality before " "	%	95.36
" after " "	%	96.51

SUMMARY OF AVERAGE RESULTS.

(Full Load Continued)

Gland Water	Cu.Ft./Hr.	49.42
" " Corrected	"	47.00
Sealing Water	"	-----
" " "	"	------
Condensed Steam (Gross)	"	324.03
" " Corrected (Gross)	"	319.2
" " Less Gland Water & Sealing H_2O		272.2
" " Temperature	Deg.F.	88.95
" "	Lbs./Hr.	16939.
Steam Consumption Wet Steam	Lbs./K.W./Hr.	33.41
" " Lbs. Dry Steam	/K.W./Hr.	32.27

SUMMARY OF AVERAGE RESULTS.

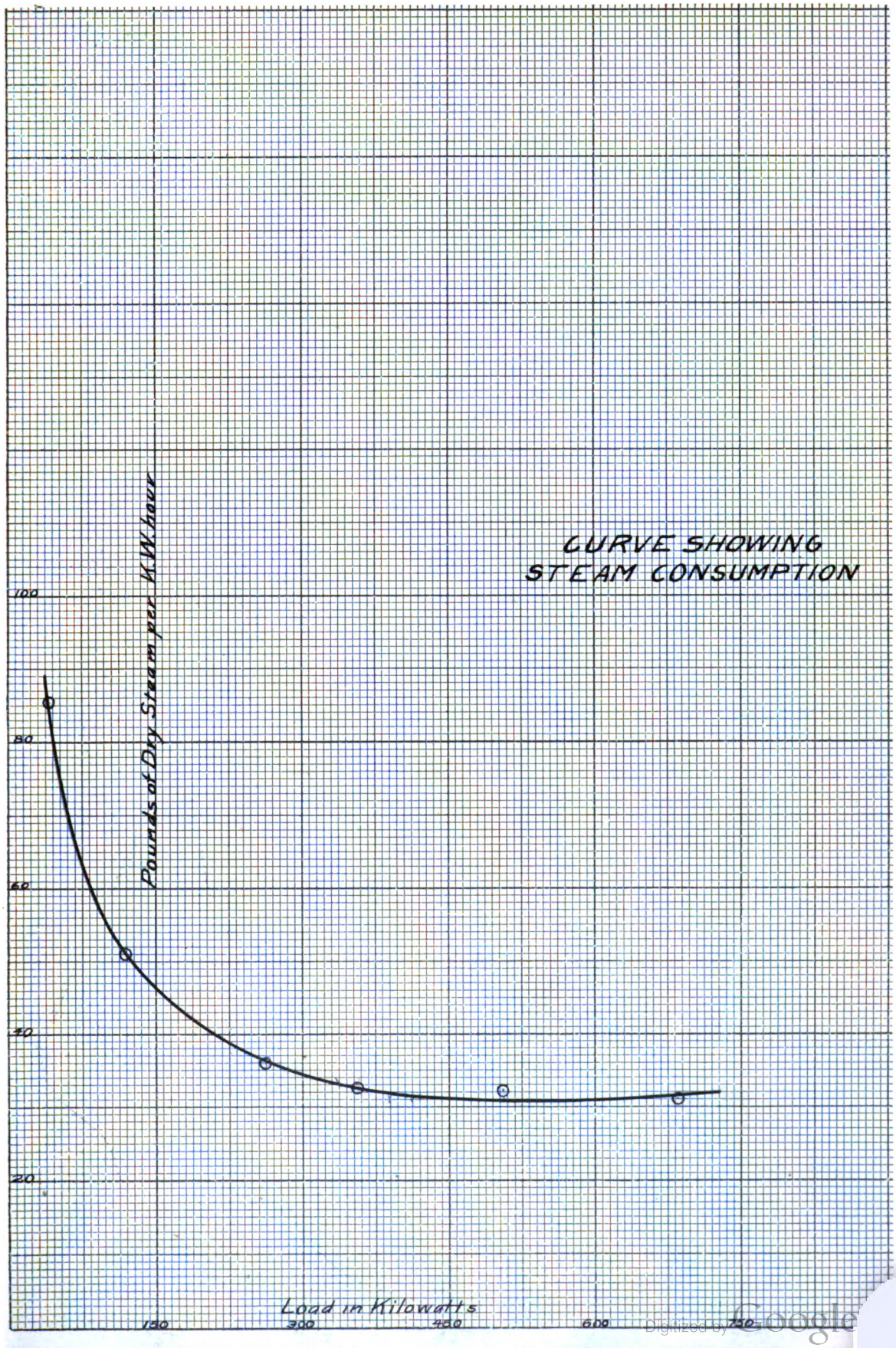
(Overload)
140 % RATED LOAD

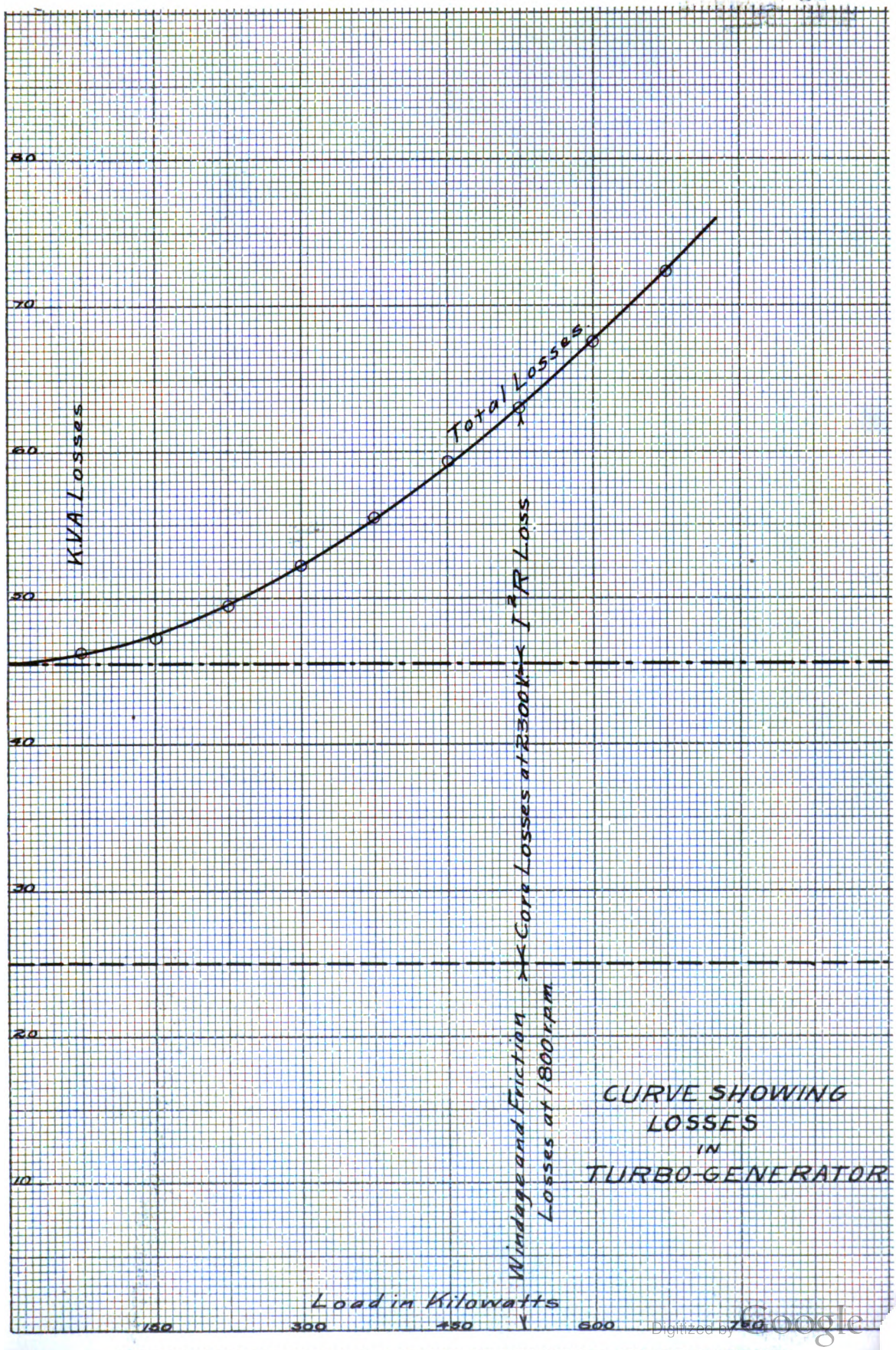
Length of Run	Hours	2.
Current 1st Phase	Amps.	173.1
" 2nd "	"	162.3
" 3rd "	"	175
Pressure	Volts	2280
Power Delivered at Switchboard	K.W.	684
Speed of Turbine	R.P.M.	1658
Exciter Current	Amps.	27.7
" Pressure	volts	96.8
Temp. of Air into Generator	Deg. F.	75.85
" " from "	"	133.1
" Rise in "	"	58.25
Vacuum at Turbine	Ins.Hg.	25.36
Barometer Pressure	" "	29.02
Boiler Pressure	#/Sq.in.	167.6
Pressure before Reg. Valve	"	163.5
" after " "	"	148.5
Quality before " "	%	96.34
" after " "	%	96.8

SUMMARY OF AVERAGE RESULTS.

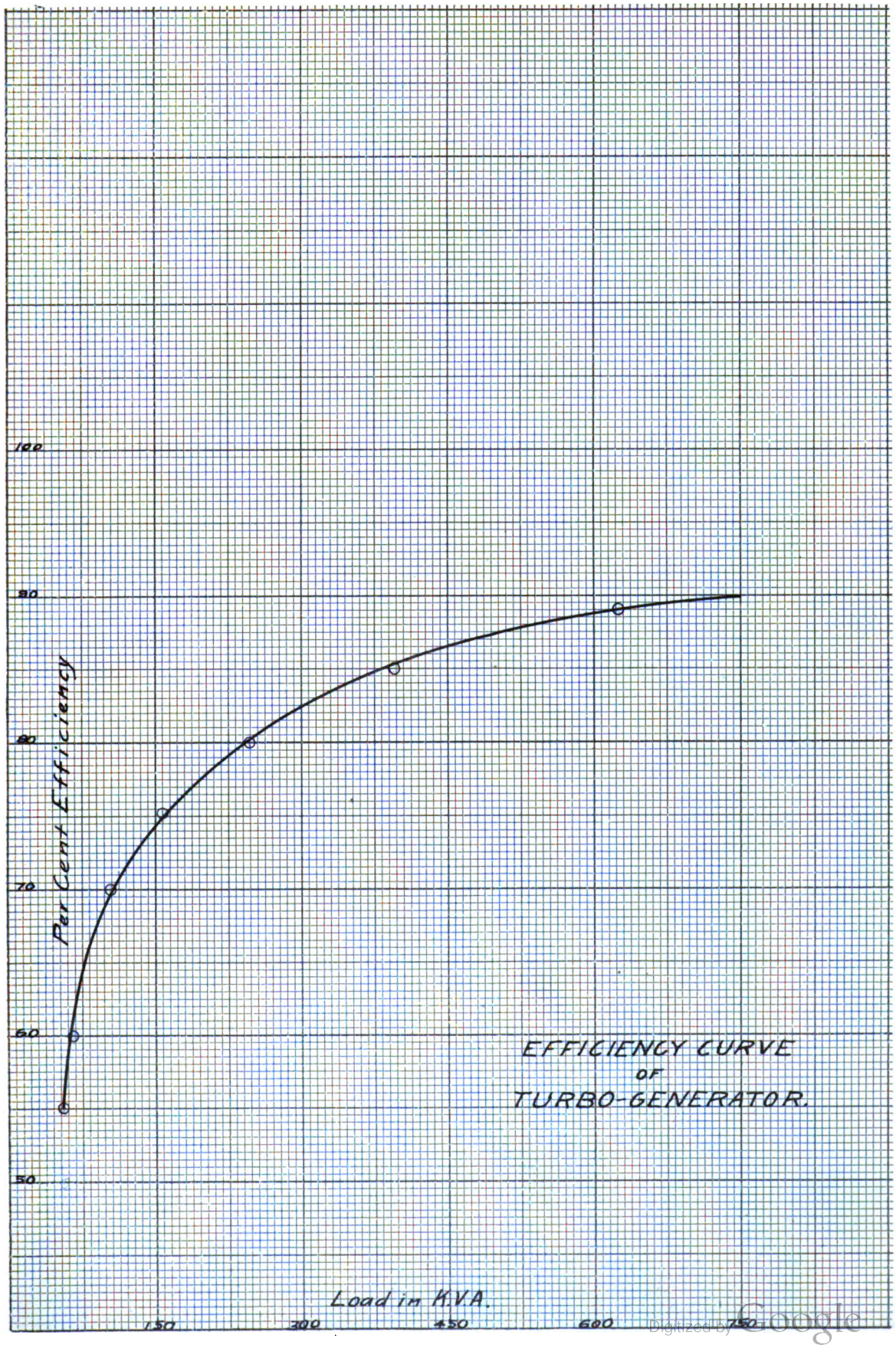
(Overload Continued)

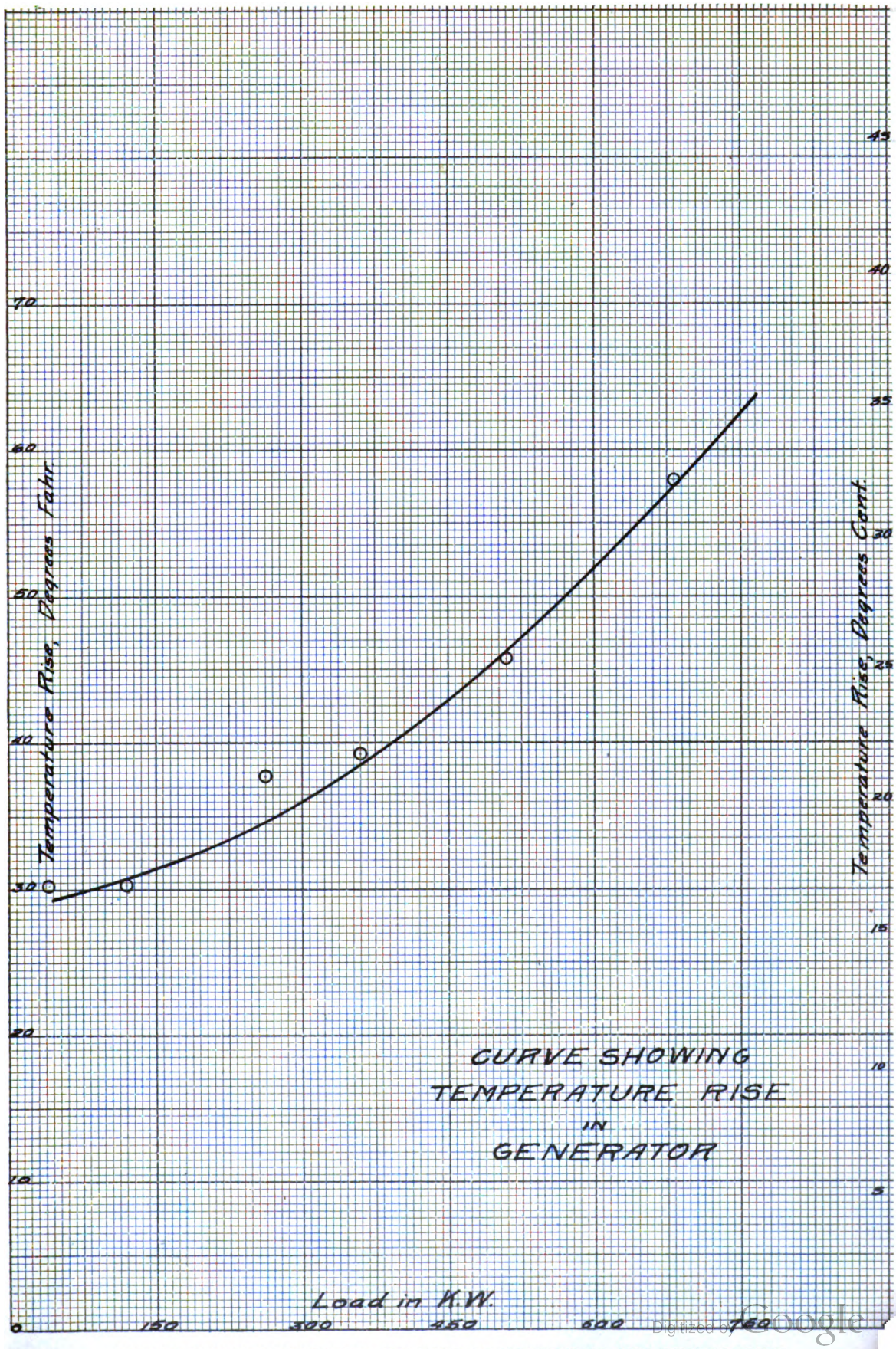
Gland Water	Cu.ft./Hr.	49.94
" " Corrected	"	47.60
" "	Lbs./Hr.	2951.
Sealing Water Corrected	"	-----
Condensed Steam (Gross)	Lbs.	25018
" " Corrected (Gross)	"	22067
" " Less Gland & Sealing water Lbs.		
" " Temperature	Deg. F.	98.67
" "	#/Hr	22067.
Steam Consumption, Wet Steam Lbs./K.W./Hr.		32.2
" " Dry Steam Lbs./K.W./Hr.		31.13





CURVE SHOWING LOSSES IN TURBO-GENERATOR





CONCLUSION.

The test as a whole was quite satisfactory. The high steam consumption at all loads was due to several causes, the principle ones being the absence of super-heated steam, a poor vacuum and waste of steam from the high pressure stuffing box to the vacuum end of the turbine. The poor vacuum was due to the fact that there was some loss in the pipe between the turbine and the air pump. At full load and overload, the vacuum pumps were unable to maintain a vacuum of over twenty-six and one-half inches at the turbine, with a barometer pressure of twenty-nine and three-tenths inches. Under the best conditions the vacuum should have been at least twenty-eight and three-tenths inches. Had this vacuum been attained, the steam consumption would have been much less.

The steam was quite wet at all loads except the lowest. Some manufacturers of turbines have determined that the loss due to wet steam is about twice the per cent. of entrained water, but the loss may have been very much greater than this amount. As the percentage of water in the steam at full load is about three and one-half per cent., it would be advisable to put in a superheater to eliminate this waste.

It has been suggested that placing the condenser at right angles to, and under the low pressure end of the turbine, with the turbine exhaust directly connected to the

steam inlet of the condenser, would eliminate the piping loss between the turbine and the condenser.

Considerable difficulty was experienced with leakage in the high pressure stuffing box. At the larger loads the leakage was very great. In order to take care of this steam, a three inch exhaust pipe was introduced, connecting this stuffing box with the exhaust end of the turbine. Consequently, a large amount of steam passed directly through the pipe without doing work. If this pipe were removed and if the stuffing box leakage were eliminated, there would no doubt be a large increase in efficiency.

The shape of the curve showing the temperature rise in the generator shows that the generator would give nearly twice its rated power before the temperature rise would exceed the maximum allowable amount. This seems to indicate that the generator is too large for the turbine.

The Allberger dry condenser pump is supposed to be a two stage pump. The air cylinders are of the same size and are placed in tandem, the discharge of the first being the suction of the second. On account of this arrangement the cylinder farthest from the condenser necessarily does all the work; the cylinder nearest the condenser can only operate when the second cylinder fails to work. We thus have a reserve air cylinder and not a two stage pump.

Hourly Averages of Condensed Steam,

Meter Readings and Tank Weights.

	Meter Reading			Tank Reading	
Load	Average Cu.Ft./Hr.	Temp. Deg.F.	#/Hr.	#/Hr.	% Tank
0	132.01	77.0	8201	7790	105.4
1/4	180.80	70.0	11260	11312.5	99.6
1/2	253.13	71.6	15770	15642	100.8
3/4	290.48	80.0	18040	17801	101.3
4/4	324.03	89.0	20130	20094	100.1
				Average,	101.4

Readings of Meter No. 591374 equal 104% of true readings.

Calibration Meter No.591373.

Meter for Basement Gland Water.

Test	Meter cu.ft.	Lbs.	Tank Lbs.	% Tank
1. Tare	8762.4		487	
Gross	9765.5		665	
Net	3.1	193.6	179	108.1
2. Tare	8766.5		666	
Gross	8769.5		843	
Net	3.0	187.3	177	105.8
3. Tare	8770.5		843	
Gross	8773.5		1025	
Net	3.0	187.3	182	102.8
4. Tare	8774.5		1025	
Gross	8777.5		1202	
Net	3.0	187.3	177	105.8
5. Tare	8778.5		1202	
Gross	8781.5		1383	
Net	3.0	187.3	181	103.4
			Av.	105.18

Test # 1. March 18,'08. No Load.

Switchboard Readings.

Time	Pressure Volts	Current. 1st Phase Amps.	2nd Phase Amps.	3rd Phase Amps.
2 :30	2300			
2:40	2300			
2:50	2300			
3:00	2300	(These readings were so small		
3:10	2300			
3:20	2300	that the ammeters did not record		
3:30	2300	them accurately.)		
3:40	2300			
3:50	2300			
4:00	2300			
4:10	2300			
4:20	2300			
4:30	2300			
Average	2300			

Test # 1. March 18,'08. No Load.

Time	Output K.W.	Exciting Current		Speed of Turbine R. P. M.
		Amps.	Volts.	
2:30	40	24	74	1725
2:40	42	22	69	1725
2:50	42	22.5	70	1720
3:00	42	22	68	1725
3:10	42	22	69	1725
3:20	42	22	70	1720
3:30	42	22	70	1720
3:40	42	22	71	1730
3:50	42	22	71	1720
4:00	42	22	72	1740
4:10	42	22	73	1725
4:20	42	22	73	1725
4:30	42	22	73	1735
Average	41.85	22.19	71.00	1725.83

Test # 1. March 18,'08. No Load.

Time	Pressure at Reg. Valve Pounds per Square Inch. Before	After	Vacuum Inches Hg.	Bar.Pres. Inches Hg.
2:3o	60	00	27.5	28.94
2:40	70	00	27.4	28.95
2:50	80	00	27.5	28.95
3:00	65	00	27.5	28.95
3:10	75	00	27.6	28.95
3:20	75	00	27.7	28.95
3:30	85	00	27.7	28.95
3:40	75	00	27.8	28.90
3:50	60	00	27.6	28.90
4:00	93	00	28.2	28.95
4:10	95	00	28.2	28.96
4:20	88	00	28.2	28.97
4:30	77	00	28.2	28.97
Average	76.9	00.0	27.77	28.94

Test # 1. March 18,'08. No Load.

Calorimeter Data.

Time	Boiler Pres. Lbs.per Sq.In.	U Tube Inches Hg.	Temp. Deg.F.	Quality %
2:38	167	1.90	282	98.25
2:53	160	1.90	280	98.20
3:05	156	1.90	283	98.40
3:35	154	20.00	280	98.35
3:50	165	19.00	285	98.55
4:05	155	19.00	284	98.50
4:20	157	19.00	285	98.50
4:30	155	19.00	285	98.55
Average	157.00			98.425

Test # 1. March 18,'08. No Load.

Time	Temperature of Circulating Water Deg.F. Entering	Leaving	Air Temperature at Generator Deg. F. Entering	Leaving
2:30	40	44	58	77
2:40	42	46	60	82
2:50	40	44	61	86
3:00	42	46	61	88
3:10	42	44	61	90
3:20	42	46	61	92
3:30	42	46	60	94
3:40	40	44	61	95
3:50	39	43	61	96
4:00	40	44	61	97
4:10	40	43	61	98
4:20	40	43	61	99
4:30	40	43	61	99
Average	40.708	44.30	60.61	91.07

Test # 1. March 18,'08. No Load.

Gland Water for Wet Vacuum Pump.

Meter Readings.

Time	Reading Cu.Ft.	Net Time	Net Cu. Ft.	Cu.Ft.per hour
2:17	8021.00			
3:32	8064.90	75	43.90	35.10
3:41	8070.50	9	5.60	37.32
3:55	8080.70	14	10.20	43.72
4:17	8097.80	22	17.10	46.65
4:31	8108.20	14	10.40	44.58
			Average	41.47

Test # 1. March 18,'08. No Load.

Sealing Water for Low Pressure Turbine Gland.

Meter Readings.

Time	Reading Cu. Ft.	Net Time	Net Cu.Ft.	Cu. Ft. per Hour
2:33	3700			
2:43	3707	10	47.00	40.40
2:53	3714	10	47.00	40.40
3:02	3721	9	7.00	44.80
3:12	3728	10	7.00	40.40
3:22	3736	10	8.00	46.20
3:32	3743	10	7.00	40.40
3:45	3754	13	11.60	51.15
3:53	3760	8	5.40	38.90
4:04	3767	11	7.00	36.70
4:13	3770	9	3.00	19.20
4:22	3771	9	1.00	6.40
4:32	3772	10	1.00	5.77
			Average,	34.23

Test # 1. March 18,'08. No Load.

Condensed Steam and Gland Water, Wet Vacuum Pump.

Meter Reading.

Time	Reading Cu. Ft.	Net Time	Net Cu. Ft.	Cu.Ft. Per Hour
2:20	99.50			
3:12	214.00	52	114.50	120.60
3:18	228.50	6	14.50	145.00
3:30	256.00	12	27.50	137.50
3:42	282.10	12	26.10	130.50
3:56	316.50	14	34.40	147.30
4:30	379.50	34	63.00	111.20
			Average,	132.0

Test # 1. March 18,'08. No Load.

Condensed Steam and Gland Water, Wet Vacuum Pump.

Weights.

Time	Tare	Gross	Net.	Lbs.per Hr.
9.00	220	1445	1225	8170
8.00	260	1390	1130	8475
8.00	268	1362	1094	8210
8.00	243	1315	1072	8040
8.00	270	1487	1217	9130
8.00	245	1081	846	6345
8.00	245	1066	821	6160
			Average,	7790

Test # 1. March 18,'08. No Load.

Time	Temperature of Condensed Steam Degrees F.
2:30	84
2:40	
2:50	84
3:00	
3:10	
3:20	
3:30	78
3:40	
3:50	74
4:00	
4:10	
4:20	
4:30	67
Average	77.4

Test #2. March 20,'08. 1/4 Load.

Switchboard Readings.

Current.

Time	1st Phase amps.	2nd Phase amps.	3rd Phase amps.	Pressure Volts
8:00	32	32	30	2300
8:10	32.5	32.5	30	2300
8:20	32.5	32.5	30	2300
8:30	32	32	30	2300
8:40	32	32	30	2300
8:50	32	32	30	2300
9:00	32	32	30	2300
9:10	31	31	30	2300
9:20	31	31	29	2300
9:30	31	31	29	2300
9:40	30	31	28	2300
9:50	30	31	29	2300
Average	31	31.66	29.57	2300

Test #2 . March 20,'08. 1/4 Load.

Time	Output K.W.	Exciter Current		Turbine Speed R.P.M.
		Amps.	Volts	
8:00	120	22	66	1755
8:10	125	22	67	1745
8:20	122	22	69	1735
8:30	120	22	69	1740
8:40	120	22	69	1745
8:50	120	22	70	1740
9:00	118	22	70	1740
9:10	118	22	70	1750
9:20	118	22	70	1745
9:30	117	22	71	1740
9:40	118	22	71	1755
9:50	117	22	71	1760
Average	119.33	22.00	69.417	1745.8

Test # 2. March 20,'08. 1/4 Load.

Time	Pressure at Reg.Valve Pounds per Square Inch Before	After	Vacuum Inches Hg.	Bar.Pres. Inches Hg.
8:00	100	25	28.40	29.51
8:10	95	26	28.36	29.51
8:20	80	29	27.70	29.51
8:30	93	26	27.90	29.51
8:40	115	25	28.40	29.51
8:50	113	26	28.50	29.51
9:00	105	26	28.50	29.51
9:10	120	25	28.50	29.51
9:20	122	25	28.50	29.51
9:30	110	25	28.50	29.51
9:40	107	25	28.50	29.51
9:50	122	20	28.50	29.51
Average	106.83	25.25	28.55	29.51

Test # 2. March 20,'08. 1/4 Load.

Calorimeter Data.

Time	Boiler Pres. Lbs. per sq.in.	U Tube Inch Hg.	Temp. Deg.F.	Quality %
8:30	167	1.70	285	98.40
8:50	170	1.70	283	98.20
9:30	165	1.70	286	98.50
10:00	170	1.70	286	98.30
			Average,	98.25

Test # 2. March 20,'08. 1/4 Load.

Time	Temperature of Circulating Water Deg.F.		Air Temperature at Generator Deg.F.	
	Entering	Leaving	Entering	Leaving
8:00	36	44	54	76
8:10	37	45	54	80
8:20	37	44	54	82
8:30	37	44	52	83
8:40	38	45	52	84
8:50	37	44	54	85
9:00	38	45	55	87
9:10	37	44	56	88
9:20	38	45	56	89
9:30	38	44	56	89
9:40	37	44	58	90
9:50	37	44	58	91
Average	37.25	44.33	54.917	85.33

Test # 2. March 20,'08. 1/4 Load,

Gland Water for Wet Vacuum Pump.

Meter Readings.

Time	Reading Cu. Ft.	Net Time	Net Cu.Ft.	Cu.Ft.per Hour.
8:10	8165.60	15		
8:25	8177.20	31	11.60	46.60
8:56	8201.10	31	23.90	46.30
9:21	8220.00	25	18.90	45.40
9:38	8233.33	17	13.33	47.00
9:57	8248.20	19	14.87	47.00
			Average,	46.42

Test # 2. March 20,'08. 1/4 Load.

Sealing Water for Low Pressure Gland.

Meter Readings.

Time	Reading	Net Time	Net Cu. Ft.	Cu. Ft. per Hour.
8:01	3789.50			
8:10	3796.50	9	7.00	46.7
8:21	3804.40	11	7.90	43.1
8:30	3811.60	9	7.20	48.0
8:40	3818.60	10	7.00	42.0
8:51	3827.40	11	8.80	48.0
9:01	3835.40	10	8.00	48.0
9:11	3843.50	10	8.10	48.6
9:21	3852.00	10	8.50	51.0
9:31	3860.60	10	8.60	51.6
9:41	3869.40	10	8.80	52.8
9:50	3877.20	9	7.80	52.0
10:01	3885.00	11	8.80	48.0
			Average,	47.6

Test # 2. March 20,'08. 1/4 Load.

Condensed Steam and Gland Water, Wet Vacuum Pump.

Meter Readings.

Time	Reading	Net Time	Net Cu.Ft.	Cu.ft. per Hour.
8:00	484.50			
8:22	553.40	22	68.90	187.60
8:43	620.00	21	66.60	190.40
8:49	638.45	6	18.45	184.50
9:02	675.00	13	36.55	164.30
9:08	693.25	6	18.25	182.50
9:20	730.00	12	36.75	183.80
9:26	744.22	6	18.22	182.20
9:35	777.00	9	28.78	192.00
9:41	795.10	6	18.10	181.00
10:00	851.65	19	56.55	178.50
			Average,	180.80

Test # 2. March 20,'08. 1/4 Load.

Condensed Steam and Gland Water, Wet Vacuum Pump.

Weights.

Time Minutes	Tare	Gross	Net	Lbs.per Hour
6:00	252	1394	1142	11420
6:00	262	1435	1173	11730
6:00	274	1401	1127	11270
6:00	262.5	1385	1122.5	11225
6:00	266	1382	1116	11160
6:00	275	1382	1107	11070
			Average,	11312.5

Test # 2. March 20,'08. 1/4 Load.

Time	Boiler Pressure in Pounds per Sq. In.	Temperature of Condensed Steam °F.
8:00	147	
8:10	155	67
8:20	167	89
8:30	167	
8:40	170	70
9:00	167	68
9:10	167	
9:20	167	66
9:30	165	
9:40	165	66
9:50	165	
10:00	170	66
Average,	164.7	

Test # 3. Switchboard Readings. 1/2 Load.
March 20, '08.

Time	Current. 1 st Phase amps.	2 nd Phase amps.	3rd Phase amps.	Pressure Volts
10:30	70	65	67	2300
10:40	70	65	67	2300
10:50	70	65	67.5	2300
11:00	70	65	67.5	2300
11:10	70	65	67.5	2300
11:20	70	65	67.5	2300
11:30	70	65	67.5	2300
11:40	70	65	67.5	2300
11:50	70	65	67.5	2300
12:00	70	65	67.5	2300
12:10	72	65	68	2300
12:20	72	67	70	2300
12:30	72	67.5	70	2300
12:40	72	67.5	69	2300
12:50	72	67	70	2300
1:00	72	66	68	2300
1:10	72	66	68	2300
1:20	72	65	70	2300
1:30	72	65	67	2300
Average	70.94	65.58	68.1	2300

Test # 3. March 20,08. 1/2 Load.

Time	Output K.W.	Exciter Current		Turbine Speed
		Amps.	Volts	R. P. M.
10:30	260	23	76.0	1730
10:40	260	23	76.0	1740
10:50	260	23	76.0	1750
11:00	260	23	76.0	1750
11:10	260	23	76.5	1750
11:20	260	23	76.0	1740
11:30	260	23	76.5	1740
11:40	260	23	76.0	1740
11:50	260	23	75.0	1740
12:00	260	23	76.0	1740
12:10	263	23	76.0	1740
12:20	264	23	76.5	1730
12:30	270	23	76.5	1740
12:40	264	23	76.5	1730
12:50	265	23	76.0	1750
1:00	262	23	76.5	1740
1:10	262	23	76.5	1750
1:20	262	23	76.5	1740
1:30	260	23	77.5	1740
Average	261.7	23	76.24	1742

Test # 8. March 20,08. 1/2 Load. 55

Time	Pressure at Reg.Valve. Pounds per Square Inch Before	After	Vacuum Inches Hg.	Bar.Pres. Inches Hg.
10:30 A.M.	75	60	27.85	29.51
10:40	88	52	27.85	29.50
10:50	88	52	27.80	29.50
11:00	89	52	27.80	29.50
11:10	82	51	27.80	29.50
11:20	107	55	27.80	29.50
11:30	117	55	27.80	29.50
11:40	119	52	27.74	29.50
11:50	126	52	27.76	29.50
12:00	117	51	27.76	29.50
12:10	114	50	27.76	29.50
12:20	112	52	27.70	29.50
12:30	110	52	27.67	29.50
12:40	104	55	27.70	29.49
12:50	104	57	27.67	29.49
1:00	96	52	27.66	29.48
1:20	125	52	27.67	29.48
1:20	129	51	27.65	29.45
1:30	78	52	27.63	29.45
Average	104.2	52.89	27.74	29.49

Test # 3. March 20,08. 1/2 Load.

Calorimeter Data.

Time	Bolier Pres.	U Tube Inch Hg.	TemP. Deg. F.	Quality %
10:30	155	1.7	246	96.55
11:00	165	1.7	265	97.25
11:30	165	1.7	260	97.00
12:00	165	1.7	257	96.80
12:30	165	1.5	265	97.25
1:00	165	1.7	238	95.80
1:30	165	1.5	236	95.80
				96.63

Test # 3. March 20,08. 1/2 Load.

Calorimeter Data.

Time	Bolier Pres.	U Tube Inch Hg.	TemP. Deg. F.	Quality %
10:30	155	1.7	246	96.55
11:00	165	1.7	265	97.25
11:30	165	1.7	260	97.00
12:00	165	1.7	257	96.80
12:30	165	1.5	265	97.25
1:00	165	1.7	238	95.80
1:30	165	1.5	236	95.80
				96.63

Test # 8. March 20,'08. 1/2 Load.

Time	Temperature of Circulating Water Deg.F.		Air Temperature at Generator Deg.F.	
	Entering	Leaving	Entering	Leaving
10:30	39	52	59	94
10:40	38	53	60	95
10:50	39	54	61	96
11:00	39	53	62	96
11:10	38	52	56	96
11:20	40	53	56	96
11:30	41	54	56	96
11:40	40	53	56	96
11:50	42	54	56	96
12:00	39	54	55	96
12:10	40	54	55	95
12:20	40	53	53	95
12:30	40	55	53	95
12:40	40	54	61	96
12:50	41	55	61	97
1:00	39	54	63	98
1:10	42	55	61	98
1:20	41	54	62	98
1:30	42	55	65	100
Average	40	53.74	58.47	96.26

Test # 3. March 20,'08. 1/2 Load.

Gland Water for Wet Vacuum Pump.

Meter Readings.

Time	Reading Cu. Ft.	Net Time	Net Cu. Ft.	Cu.Ft. per hour.
10:30	8273.7			
10:50	8289.1	20	15.4	46.2
11:05	8300.55	15	11.45	45.8
11:30	8319.85	25	19.3	46.0
11:53	8337.55	23	17.5	45.7
12:48	8380.22	55	42.87	46.8
12:59	8388.75	11	5.83	46.5
1:30	8412.62	31	23.87	46.2
			Av,	46.31

Test #3. March 20,'08. 1/2 Load.

Sealing Water for Low Pressure Turbine Gland.

Meter Readings.

Time.	Reading	Net Time	Net Cu.Ft.	Cu.Ft. per Hour.
10:31	3910.			
10:41	3919.15	10	9.15	54.85
10:51	3928	10	8.85	53.10
11:01	3936.3	10	8.3	49.75
11:11	3944.7	10	8.4	50.40
11:21	3953.0	10	8.3	49.75
11:31	3961.8	10	8.8	52.80
11:41	3970.45	10	8.65	51.85
11:51	3979.05	10	8.6	51.55
12:01	3987.6	10	8.55	51.30
12:11	3996.3	10	8.7	52.20
12:21	4004.9	10	8.6	51.55
12:31	4013.6	10	8.7	52.20
12:43	4024.0	12	10.4	52.00
12:53	4032.6	10	8.6	51.55
1:01	4039.5	8	6.9	51.80
1:11	4048.1	10	8.6	51.55
1:22	4057.46	11	9.36	51.25
1:31	4065.14	9	7.68	51.20
				Average, 51.70

Condensed Steam and Gland Water, Wet Vacuum Pump.

Meter Reading.

Time	Reading	Net Time	Net Cu.Ft.	Cu.Ft. per Hour
10:30	954.60			
10:32	961.00	2	6.4	
10:37	982.50	5	21.5	258.00
10:49	1031.00	12	48.5	242.50
10:54	1051.90	5	20	240.00
11:02	1089.00	8	38.0	285.00
11:07	1110.02	5	21.02	252.00
11:16	1146.00	9	35.98	240.00
11:21	1167.45	5	21.45	257.00
11:30	1027.55	9	40.10	267.00
11:35	1226.00	5	18.45	221.00
11:40	1247.18	5	21.18	254.50
11:52	1299.00	12	51.72	258.50
11:57	1320.15	5	21.15	254.00
12:13	1366.00	16	45.85	
12:18	1387.13	5	21.13	253.50
12:30	1469.37	12	81.87	408.00
12:35	1490.37	5	21.37	256.50
12:50	1547.00	15	56.63	236.50
12:55	1568.82	5	21.82	262.00
1:11	1636.00	16	67.18	252.00
1:16	1657.10	5	21:10	253.00
1:30	1715.20	14	59.10	252.00
			Average,	253.1

Test #3. Mardh 20,'08. 1/2 Load.

Condensed Steam and Gland Water, Wet Vacuum Pump.

Weights.

Time	Tare	Gross	Net	Lbs.per Hr.
5:00	255	1570	1315	15780
5:00	278	1559	1281	15372
5:00	280.5	1572.5	1292	15504
5:00	276.5	1590	1313.5	15762
5:00	303.5	1603.5	1300	15600
5:00	265	1565	1300	15600
5:00	278	1577.5	1299.5	15594
5:00	275	1587	1312	15744
5:00	270	1610.5	1340.5	16086
5:00	274	1572	1298	15576
			Average,	15642

Test # 8. March 20,'08. 1/2 Load.

Time	Boiler Pressure in Pounds per Sq. In.	Temperature of Condensed Steam °F.
10:30	150	68
10:40	155	
10:50	155	69
11:00		70
11:10	160	74
11:20	160	80
11:30	160	71
11:40	155	
11:50	160	69
12:00	160	69
12:10	160	70
12:20	155	
12:30	140	75
12:40	150	
12:50	155	71
1:00	160	71
1:10	155	73
1:20	150	
1:30	142	
Average	154.55	71.6

Switchboard Readings.

Current.

Time	1 st Phase amps.	2nd Phase amps.	3 rd Phase amps.	Pressure Volts
6:00	95	90	85	2300
6:10	92.5	94	82	2300
6:20	92	92	80	2300
6:30	90	94	88	2300
6:40	90	95	85	2300
6:50	90	95	87	2300
7:00	92	90	88	2300
7:10	90	95	88	2300
7:20	92	95	89	2300
7:30	90	95	89	2300
7:40	90	95	90	2300
7:50	90	95	90	2300
8:00	90	94	90	2300
8:10	90	94	89	2300
8:20	90	95	90	2300
8:30	90	95	90	2300
8:40	90	90	90	2300
8:50	90	95	90	2300
9:00	92	95	90	2300
Average	90.8	93.85	87.9	2300

Test # 4. March 20, '08. 3/4 Load. 64

Time	Output K. W.	Exciter Current		Turbine Speed R.P.M.
		Amps.	Volts.	
6:00	360	78	24	1760
6:10	355	78	24	1750
6:20	350	78	24	1750
6:30	360	80	24	1740
6:40	360	80	24	1750
6:50	360	80	24	1740
7:00	355	80	24	1730
7:10	355	80	24	1740
7:20	360	80	24	1740
7:30	360	80	24	1740
7:40	360	80	24	1740
7:50	360	80	24	1740
8:00	355	81	24	1740
8:10	355	82	24.5	1730
8:20	360	81	24	1750
8:30	360	81	24	1740
8:40	350	81	24	1730
8:50	360	81	24	1740
9:00	370	81	24	1730
Average	358.1	80.12	24.0	1741.05

Test # 4. March 20,'08. 3/4 Load.

Time	Pressure at Reg.Valve Pounds per Sq. Inch. Before	After	Vacuum Inches Hg.	Bar.Pres. Inch Hg.
6:00	109	65	27.35	29.39
6:10	123	62	27.30	29.39
6:20	127	60	27.30	29.39
6:30	109	66	27.30	29.39
6:40	117	62	27.20	29.39
6:50	110	65	27.30	29.39
7:00	88	67	27.10	29.39
7:10	116	66	27.23	29.39
7:20	118	60	27.20	29.395
7:30	95	65	27.225	29.395
7:40	95	64	27.325	29.395
7:50	97	64	27.325	29.395
8:00	98	65	27.350	29.395
8:10	77	64	27.300	29.395
8:20	78	67	27.325	29.395
8:30	112	63	27.325	29.395
8:40	110	65	27.325	29.395
8:50	88	62	27.325	29.395
9:00	92	65	27.325	29.395
Average	102.84	64.05	27.286	29.392

Test # 4. March 20,'08. 3/4 Load!

Calorimeter Data.

Time	Bolier Pres.	U Tube Inch Hg.	Temp. Deg. F.	Quality %
6:00				
6:10				
6:20	170	1.8	232	95.2
6:30	171	1.75	238	95.65
6:45	165	1.8	230	95.25
6:50				
7:00	164	1.6	227	95.1
7:10				
7:20				
7:30	170	1.8	227	95.0
7:40				
7:50				
8:00	170	1.8	226	95.0
8:10				
8:20	170	1.8	232	95.0
8:30				
8:40				
8:50				
9:00	163	1.8	234	95.5
			Average,	95.21

Test #4. March 20,'08. 3/4 Load!

Time	Temperature of Circulating Water Deg.G.		Air Temperature at Generator Deg. F.	
	Entering	Leaving	Entering	Leaving
6:00	41	60	60	96
6:10	43	58	59	97
6:20	44	58	59	98
6:30	42	58	57	98
6:40	44	59	62	99
6:50	44	61	66	100
7:00	43	60	67	102
7:10	43	59	67	103
7:20	44	60	56	101
7:30	43	59	58	101
7:40	43	59	66	103
7:50	44	58	67	104
8:00	43	60	67	105
8:10	44	59	68	105
8:20	44	60	68	106
8:30	43	59	68	106
8:40	43	59	58	104
8:50	43	60	57	103
9:00	43	60	58	102
	43.2	59.25	62.58	101.79

Test #4. March 20,'08. 3/4 Load.

Gland Water for Wet vacuum Pump.

Meter Readings.

Time	Reading Cu. Ft.	Net Time	Net. Cu. Ft.	Cu.Ft.per Hour.
6:01	8544.12			
6:42	8575.95	41	31.83	46.60
7:01	8590.62	19	14.67	46.35
7:34	8616.15	33	25.53	46.40
8:01	8637.03	27	20.88	46.40
8:36	8664.00	36	26.97	46.25
9:01	8683.32	25	19.32	46.35
			Average,	46.39

Test # 4. March 20,'08. 3/4 Load.

Sealing water for Low Pressure Turbine gland.

Meter Readings.

Time	Reading	Net Time	Net Cu.ft.	Cu.Ft. per Hour
6:00	4098.1			
6:10	4104.65	10	6.55	39.30
6:20	4113.1	10	8.45	50.70
6:30	4121.5	10	8.40	50.60
6:40	4129.8	10	8.30	50.10
6:50	4137.8	10	8.00	48.00
7:00	4145.96	10	8.16	49.00
7:10	4154.1	10	8.14	48.80
7:20	4162.2	10	8.10	48.60
7:30	4170.55	10	8.35	50.10
7:40	4178.9	10	8.35	50.10
7:50	4187.2	10	8.30	49.75
8:00	4195.55	10	8.35	50.10
8:10	4203.9	10	8.35	50.10
8:20	4212.2	10	8.30	49.75
8:30	4220.5	10	8.30	49.75
8:40	4228.8	10	8.30	49.75
8:50	4237.1	10	8.30	49.75
9:00	4245.4	10	8.30	49.75
			8.217	49.11

Test #4. March 20,'08. 3/4 Load.

Condensed Steam and Gland Water, Wet Vacuum Pump.

Meter Readings.

Time	Reading	Net Time	Net Cu.Ft.	Cu.Ft.per Hour
6:01	2091.3			
:		4	19	285.0
:		4	19.5	292.5
		4	19.65	295
7:01	2381.91	60	290.61	290.61
		4	19.85	98.80
		4	19.25	289.00
		4	19.2	288.00
		4	19.33	290.00
8:01	2671.75	60	290.84	290.84
		4	19.28	289.50
		4	19.20	288.00
9:01	2961.08	60	289.33	289.33
			Average,	290.48

Test # 4. March 20,'08. 3/4 Load.

Condensed Steam and Gland Water, Wet Vacuum Pump.

Weights.

Time Minutes	Tare	Gross	Net	Lbs.per Hr.
4	255	1424.5	1169.5	17540
4	266	1462.5	1195.5	17930
4	256	1464.5	1208.5	18130
4	255	1470.5	1215.5	18220
4	271	1452.0	1181.0	17710
4	255	1431.0	1176.0	17630
4	259	1435.0	1176.0	17630
4	256	1441.0	1185.0	17780
4	263	1444.0	1181.0	17710
				17801

Test # 4. March 20,'08. 3/4 Load.

Time	Temperature of Condensed Steam Deg.F.	Boiler Pressure in Pounds per Sq. In.	
6:00	79		
6:10	79		
6:20	79		
6:30	79		
6:40	79.	171	171
6:50	78.8		
7:00	80		
7:10	79	164	163
7:20	84	165	165
7:30	83	170	169
7:40	81	171	170
7:50		170	169
8:00	82	168	167
8:10	81	169	167
8:20		171	170
8:30	80.5	169	167
8:40	80	178	176
8:50		173	173
9:00	———	163	162
Average	80.4	169.2	168.25

Test # 5. April 9,08. Full Load.

Switchboard Readings.

Time	Current. 1st Phase Amps.	2nd Phase Amps.	3rd Phase Amps.	Pressure Volts.
10:30	130	125	130	2300
10:40	130	122	125	2300
10:50	130	120	126	2300
11:00	130	125	130	2300
11:10	130	125	130	2300
11:20	130	120	130	2300
11:30	130	125	125	2300
11:40	130	125	125	2300
11:50	130	12o	127	2300
12:00	130	120	125	2300
12:10	131	125	133	2300
12:20	130	130	135	2300
12:30	127	124	125	2300
12:40	125	125	127	2300
12:50	127	123	126	2300
1:00	127	123	126	2300
1:10	127	123	127	2300
1:20	127	123	127	2300
1:30	130	125	130	2300
1:40	130	125	127	2300
1:50	130	125	130	2300
2:00	130	125	130	2300

Switchboard Readings (Continued)

Time	Current. 1st Phase Amps.	2nd Phase Amps.	3rd Phase Amps.	Pressure Volts.
2:10	130	125	130	2300
2:20	130	125	130	2300
2:30	127	125	128	2300
2:40	127	127	127	2300
2:50	126	125	125	2300
3:00	130	125	125	2300
3:10	127	125	125	2300
3:20	130	125	127	2300
3:30	127	123	125	2300
3:40	127	125	125	2300
3:50	130	125	125	2300
4:00	130	125	125	2300
4:10	130	125	125	2300
4:20	127	123	127	2300
4:30	127	123	127	2300
4:40	130	125	125	2300
4:50	130	125	127	2300
5:00	127	123	127	2300
5:10	127	123	127	2300
5:20	127	123	125	2300
5:30	130	125	127	2300

Switchboard Readings (Continued)

Time	Current. 1st Phase Amps.	2nd Phase Amps.	3rd. Phase Amps.	Pressure Volts
5:40	127	125	124	2300
5:50	127	127	123	2300
5:60	130	127	130	2300
Average	128.7	124.1	127.1	2300

Test # 5. April 9,'08. Full Load

Time	Output K.W.	Exciter Current		Turbine Speed R.P.M.
		Amps	Volts	
10:30	520	25.5	86	1650
10:40	510	25.5	87	
10:50	500	25.5	87	1660
11:00	510	25.5	87	1660
11:10	510	25.5	87	1660
11:20	505	25.5	87	1660
11:30	500	25	87	1660
11:40	505	25	87	1660
11:50	500	25	86.5	1657
12:00	500	25	86	1660
12 :10	515	25	86.5	1660
12:20	525	25	87	1660
12:30	500	25	87	1660
12:40	500	25.5	87	1660
12:50	500	25.5	87	1660
1:00	500	25.5	87	1665
1:10	500	25.5	87	1660
1.20	500	25.5	87	1655
1.30	520	25.5	87	1670
1.40	520	25.5	87	1660
1.50	520	25.5	87	1670
2:00	520	25.5	87.5	1680

(Continued)

Time	Output K.W.	Exciter Current		Turbine Speed R.P.M.
		Amps.	Volts	
2:10	520	25.5	87	1660
2:20	520	25.5	87.5	1660
2:30	500	25.5	88	1670
2:40	500	25.5	88	1660
2:50	500	25.5	88	1660
3:00	500	25.5	88	1660
3:10	500	25.5	88	1660
3:20	510	25.5	88	1670
3:30	500	25.5	88	1660
3:40	500	25.5	87	1660
3:50	510	25.5	87.5	1660
4:00	510	25.5	87.5	1660
4:10	510	25.5	87	1660
4:20	510	25.5	87	1660
4:30	500	25.5	87	1660
4:40	510	25.5	86.5	1660
4:50	510	25.5	88	1660
5:00	500	25.5	86.5	1670
5:10	500	25.5	86.5	1670
5:20	500	25.5	88	1660
5:30	510	25.5	87	1660

(Continued)

Time	Output K.W.	Exciter Current		Turbine Speed R.P.M.
		Amps.	Volts	
5:40	500	25.5	86.5	1670
5:50	500	25.5	88	1660
6:00	500	25.5	88	1660
Average	507	25.41	87.2	1662

Test # 5. April 9,'08. Full Load.

Time	Temperature of Circulating Water Deg.F.		Air Temperature at Generator Deg. F.	
	Entering	Leaving	Entering	Leaving
10:30	47	74	65	116
10:40			64	117
10:50	47	72	64	108
11:00	48	73	64	108
11:10	47	73	64	108.5
11:20	47	74	65	109
11:30	48	74	66	110
11:40	47	73	66	110
11:50	48	73	67	111
12:00	48	74	68	111
12:10	48	74	67	112
12:20	48	74	67	112
12:30	48	74	67	112
12:40	49	73	68	113
12:50	49	73	68	113
1:00	49	73	69	113
1:10	49	74	69	117
1:20	49	74	69	114
1:30	50	74	68	114
1:40	50	75	69	114
1:50	50	75	68	115
2:00	50	75	70	115

(Continued)

Time	Temperature of Circulating Water Deg.F.		Air Temperature at Generator Deg. F.	
	Entering	Leaving	Entering	Leaving
2:10	51	75	70	115
2:20	51	76	69	116
2:30	51	76	69	116
2:40	50	76	69	116
2:50	5o	75	68	116
3:00	50	75	68	116
3:10	50	75	69	116
3:20	51	76	70	116.5
3:30	51	76	70	116.5
3:40	51	75	70	116.5
3:50	51	75	71	116.5
4:00	51	75	71	117
4:10	50	75	70	117
4:20	51	75	71	117
4:30	51	75	70	117
4:40	51	75	71	117
4:50	51	75	71	117
5:00	51	75	71	117
5:10	51	75	71	117
5:20	51	76	71	117
5:30	52	76	71	117.5

(Continued)

Time	Temperature of Circulating Water Deg.F. Entering	Leaving	Air Temperature at Generator Deg. F. Entering	Leaving
5:40	52	76	71	117.5
5:50	52	76	71	117.5
6:00	52	76	70	117.5
Average	40.7	74.6	68.6	114.5

Calorimeter Data.

Time	Boiler Pres. Lbs.per Sq.In.	U Tube Inch Hg.	Temp. Deg.F.	Quality %
10:55	166	1.6	229	95.04
11:45	165	1.6	235	95.5
12:18	161	1.6	242	95.9
12:48	165	1.8	220	
1:18	166	1.6	242	95.9
1:48	166	1.6	230	95.2
2:18	162	1.6	229	95.2
2:48	161	1.6	231	95.3
3:18	161	1.6	224	95.0
3:48	162	1.6	230	95.2
4:18	166	1.65	235	95.4
4:48	159	1.65	220	94.6
5:18	160	1.65	232	95.3
5:48	157	1.65	237	95.8
6:05	158	1.6	239	95.8
			Average,	95.36

Test # 5. April 9,'08. Full Load.

Gland Water for Wet Vacuum Pump.

Meter Readings.

Time	Reading Cu. Ft.	Net Time	Net Cu.Ft.	Cu.Ft.per Hour
10:31	5900.13			
11:31	5949.41	60	49.28	49.28
12:31	5998.74	60	49.33	49.33
1:31	6048.18	60	49.44	49.44
2:31	6097.80	60	49.62	49.62
3:31	6146.40	60	49.60	49.60
4:31	6195.50	60	49.10	49.10
5:31	6244.82	60	49.32	49.32
6:01	6269.65	30	24.83	49.66
			Average,	49.42

Test # 5. April 9,'08. Full Load.

Condensed Steam and Gland Water, Wet Vacuum Pump.

Meter Readings.

Time	Reading	Net Time	Net Cu.Ft.	Cu. Ft per Hour
10:31	5681.5			
11:31	6011.5	60	330.0	330.00
12:31	6339.5	60	326.0	326.00
1:31	6664.8	60	325.3	325.30
2:31	6999.0	60	334.2	334.20
3:31	7314.25	60	315.25	315.25
4:31	7637.1	60	322.95	322.85
5:31	7960.5	60	323.4	323.40
6:01	8123.1	30	152.6	315.20
			Average,	324.025

Test # 5. April 9,'08. Full Load.

Condensed Steam and Gland Water,Wet Vacuum Pump.

Weights.

Time Minutes	Tare	Gross	Net	Lbs.Per Hh.
4	238	1644	1406	21090
4	256	1560	1304	19570
4	258	1609	1351	20275
4	251	1587	1336	20050
4	251	1622	1371	20560
4	254	1569	1315	19710
4	251	1568	1317	19750
4	251	1567	1317	19750
			Average,	20094

Time	Pressure at Reg. Valve Pounds per Square Inch Before	After	Vacuum Inches Hg.	Bar.Pres Inches Hg.
10:30	156	107	27.8	29.42
10:40			27.9	
10:50	158	105	27.9	29.42
11:00			27.7	29.40
11:10	158	106	27.7	29.39
11:20	157	107	27.7	29.38
11;30	158	107	27.8	29.39
11:40	154	105	27.8	29.37
11:50	160	100	27.8	29.35
12:00	157	107	27.8	29.34
12:10	162	105	27.82	29.34
12:20	160	110	27.8	29.32
12:30	158	103	28.0	29.31
12:40	162	105	27.7	29.31
12:50	158	104	27.9	29.30
1:00			27.9	29.29
1:10	159	105	27.5	29.32
1:20	162	102	27.4	29.33
1:30	160	105	27.6	29.34
1:40	161	105	27.8	29.34
1:50	160	110	27.6	29.34
2:00	162	107	27.8	29.33

(Continued)

Time	Pressure at Reg.Valve Pounds per Square Inch Before	After	Vacuum Inches Hg.	Bar.Pres. Inches Hg.
2:10	160	105	27.6	29.35
2:20	159	105	27.7	29.32
2:30	160	104	27.9	29.32
2:40	160	100	28.0	29.32
2:50	160	100	27.o	29.32
3:00	159	103	27.9	29.32
3:10	160	102	27.9	29.33
3:20	158	103	27.9	29.32
3:30	155	103	28.0	29.27
3:40	160	102	27.0	29.28
3:50	160	103	27.9	29.27
4:00	160	103	27.9	29.27
4:10	160	102	27.5	29.27
4;20	164	102	27.9	29.26
4:30	161	101	27.7	29.26
4:40	160	101	27.9	29.26
4:50	150	110	27.6	29.26
5:00	162	103	27.9	29.26
5:10	160	102	27.9	29.26
5:20	157	104	27.7	29.26
5:30	157	104	27.9	29.24

(Continued)

Time	Pressure at Reg.Valve Pounds per Square Inch Before	After	Vacuum Inches Hg.	Bar.Pres. Inches Hg.
5:40	160	104	27.9	29.24
5:50	152	105	27.5	29.24
6:00	155	105	27.7	29.23
Average	159	104.2	26.44	29.31

Test # 5. April 9,'08. Full Load.

Time	Tempearture Cond. Steam	Temperature Vacuum
10:30	85	255
11:05	93	259
11:30	90	267
12:00	89	267
12:10	87	266
2:10	90.5	279
2:30	86	279
4:15	88	277
5:15	89	277
6:05	91	278
Average	88.95	270.4

Test # 6. April 10,'08. Overload.

Switchboard Readings.

Current.

Time	1st Phase Amps.	2nd Phase Amps.	3rd Phase Amps.	Pressure Volts
12:40	190	165	170	2240
12:50	180	165	180	2280
1:00	175	175	180	2300
1:10	175	165	180	2300
1:20	175	160	180	2300
1:30	180	160	175	2300
1:40	175	160	175	2300
1:50	170	160	170	2300
2:00	170	160	170	2280
2:10	170	160	170	2260
2:20	170	160	175	2260
2:30	170	160	175	2260
2:40	170	160	175	2260
Average	173.1	162.3	175	2280

Test # 6. April 10,'08. Overload.

Time	Output K.W.	Exciter Current		Turbine Speed R. P. M.
		Amps.	Volts	
12:40	680	28	97	1650
12:50	700	28	95	1650
1:00	700	28	96	1650
1:10	700	28	97	1660
1:20	690	28	97	1680
1:30	690	27.5	97	1660
1:40	675	27.5	97	1660
1:50	675	27.5	97	1650
2:00	675	27.5	97	1650
2:10	675	27.5	97	1650
2:20	675	27.5	97	1660
2:30	675	27.5	97	1670
2:40	675	27.5	97	1660
Average	684	27.7	96.8	1658

Test # 6. April 10,'08. Overload.

Time	Pressure at Reg.Valve Pounds per Square Inch. Before	After	Vacuum Inches Hg.	Bar.Press. Inches Hg.
12:40	167	155	26.9	29.01
12:50	162	150	26.9	29.01
1:00	161	148	26.8	29.02
1:10	165	150		29.02
1:2 0	167	156		29.03
1:30	165	147		29.03
1:40	165	148		29.03
1:50	160	145		29.03
2:00	160	145		29.02
2:10	160	145		29.02
2:20	161	147		29.01
2:30	165	148		29.01
2:40	167	147		29.00
Average	163.5	148.5		29.02

Test # 6. April 10,'08. Overload.

Calorimeter Readings.

Regular

Time	Boiler Pressure Lbs.per Sq. In.	U Tube Inch Hg.	Temperature Deg. F.	Quality %
12:43	171.5	1.8	247	96.0
1:13	169	1.8	256	96.6
1:43	169	1.8	257	96.7
2:13	167.5	1.8	259	97.9
2:43	170	1.8	254	96.5
			Average,	96.34

Boiler.

12:40	172	2.5	294	98.5
1:00	167	2.4	294	98.8
1:20	169	2.5	295	98.9
1:40	169	2.5	294	98.8
2:00	165	2.5	294	98.7
			Average,	97.4

Test # 6. April 10,'08. Overload.

Time	Temperature of Circulating Water Deg.F.		Air Temperature at Generator Deg.F.	
	Entering	Leaving	Entering	Leaving
12:4o	54	86	71	115
12:50	55	86	72	117
1:00	55	86	75	119
1:10	55	87	77	120
1:20	55	88	78	137
1:30	54	88	76	140
1:40	54	88	76	140
1:50	55	88	75	140
2:00	55	87	77	140
2:10	55	87	79	140
2:20	55	87	77	140
2:30	55	86	76	141
2:40	56	87	77	142
Average	55.1	87	75.85	133.1

Test # 6. April 10,'08. Overload.

Sealing Water for Low Pressure Turbine Gland.

Meter Readings.

Time	Readings	Net time	Net Cu.Ft.	Cu.Ft. per Hour
12:40	6514.86			
1:40	6564.93	60	50.07	50.07
2:40	6614.82	60	49.98	49.89
			Average,	49.98

Test # 6. April 10,'08. Overload.

Condensed Steam and Gland Water, Wet Vacuum Pump.

Weights.

Time	Tare	Gross	Net	Lbs.per Hr.
3	254		1287	25740
3	293	1541	1251	25620
3	255	1544	1234	24680
3	262	1498	1275	25500
3	292	1537	2139	24780
3	259	1531	1239	25860
3	261	1552	1211	24220
3	276	1472	1224	24480
3	255	1500	1235	24700
3	256	1490	1230	24600
		1486	Average,	25018

Test # 6. April 10,'08. Overload.

	Time	Temperature of Condensed steam	Temperature of Vacuum
	1:10	98	264
	1:20	99	266
	1:30	99	267
	1:40	99	268
	2:00	98	269
	2:30	99	269
Average		98.67	267.33

Approved A. W. Richter

Prof. of Experimental Eng.

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